Space Weather Technical Forecast

Issued on Tuesday, 22 November 2022 at 01:09 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Daily Slight Chance of Minor Geomagnetic Storms, perhaps reducing to end UTC working week.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low in the past 24 hours, with the largest X-ray flare of the period an isolated C3.3 flare at 21/0348 UTC. This flare emanated from the largest and nominally most complex region on the disc, AR3149 in the northeastern quadrant, which finished the 24 hours as a spreading and consolidating Dso/Beta. The background X-ray flux otherwise showed a gradual reduction over the period.

The aforementioned group was one of up to five in total on the current disc, with the previous holder of most active region, AR3150 now fading on the northwestern limb and rotating out of view as a Cro/Beta. All the other groups lay along a similar line of longitude narrowly in the eastern solar hemisphere: from north to south aforementioned AR3149; AR3147, which manifested as a stable Cho/Beta; a new unnumbered and proliferating Bxo/Beta; and finally AR3148, another Bxo/Beta, but fading.

A large prominence eruption was seen from the northeastern quadrant around 21/0200UTC, with this subsequently seen in coronagraph imagery but well off the Sun-Earth line. No Earth directed Coronal Mass Ejections (CMEs) were seen in available imagery.

Solar Wind / Geomagnetic Activity: The solar wind was characteristic of connection to a weak fast wind regime, probably that from negative CH46/-, with the phi angle accordingly mostly negative (towards the Sun) throughout. There are reasons to believe that Earth is skirting the very northern edge of this feature: not least the fact the density has been a little high along with ACE EPAM LEMS, as well as STEREO A MAG and PLASTIC measurements showing a similar but damped response for being a little over a degree further from the source (and a day in advance of Earth).

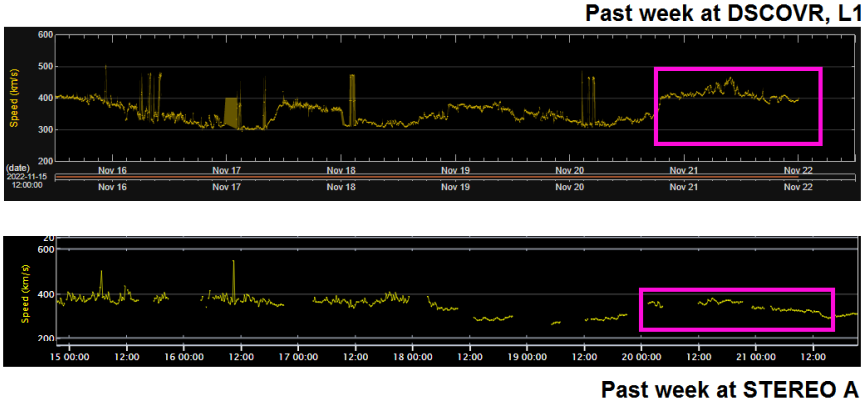

Figure 0: Solar wind speed comparision on Sun-Earth line (L1, DSCOVR), and 1.5 degrees above (STEREO A). Note that the slight orbital latitude difference is making rouhgly 50km/s difference in CH46 fast winds (pink), implying very marginal incidence of CH46/- at STEREO A especially.

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The solar wind speed was Slightly Elevated at peak, rising from 400 to a peak near 460 before losing this ground during the UTC evening to cross slightly below and finish near 380km/s. The solar wind density was also Slightly Elevated, with a peak in the upper teens ppcc that gradually waned to single figures with time. The IMF peaked at 11nT at the start of the 24-hour window, but soon fell to a more typical background range, eventually below 5nT. The north-south component was erratic but generally of diminishing magnitude, falling from an early high of +6/-11nT.

The net effect of the above solar wind measures was for provisionally mainly Quiet geomagnetic activity, falling from an early peak of Unsettled Kp '3+' in the 00-03 and 03-06UTC intervals.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10MeV) as measured at GOES16 has remained at Background levels.

High energy electron flux (greater than 2MeV) at GOES16 was at Normal Background levels throughout. Electron fluence levels remained well below Active (1e8 integrated pfu) levels. Observed fluence at 22/0001UTC was 1.5e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to remain Low, with a daily Slight Chance of isolated M-class X-ray flares.

Solar Wind / Geomagnetic Activity: There is one CME in the forecast that may glance Earth between days one and two, Tuesday 22 and Wednesday 23 November. This is the large filament lift-off from 19 November that crossed the solar meridian to give a northwestward-heading northeastern quadrant filament.

The current fast wind is now thought to have peaked below forecast expectations, and should wane in earnest through day one. A slow regime should follow for a time, perhaps interrupted by the above CME before a second fast wind potentially arrives on day three, Thursday 24 November. A third fast wind due to follow this on day four by 27-day persistence is not expected until the UTC weekend.

The upshot of the above forecast is a daily Slight Chance of Minor Geomagnetic Storm G1 on days one to three (Tuesday to Thursday inclusive), probably falling to Quiet or Unsettled on Friday 25 November, with this late quieter interlude of low confidence.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10MeV) observed by GOES16 is expected to remain at Background levels throughout.

Electron flux is forecast to remain near currently observed levels at GOES16, with a muted response to the weaker than anticipated CH46/-. The next fast wind is not likely to significantly alter this regime, and CH48 is both later and more tenuous than on last pass, meaning that 24-hour integrated fluence is Expected to remain below Active throughout, albeit with slightly reducing confidence to end the UTC week.

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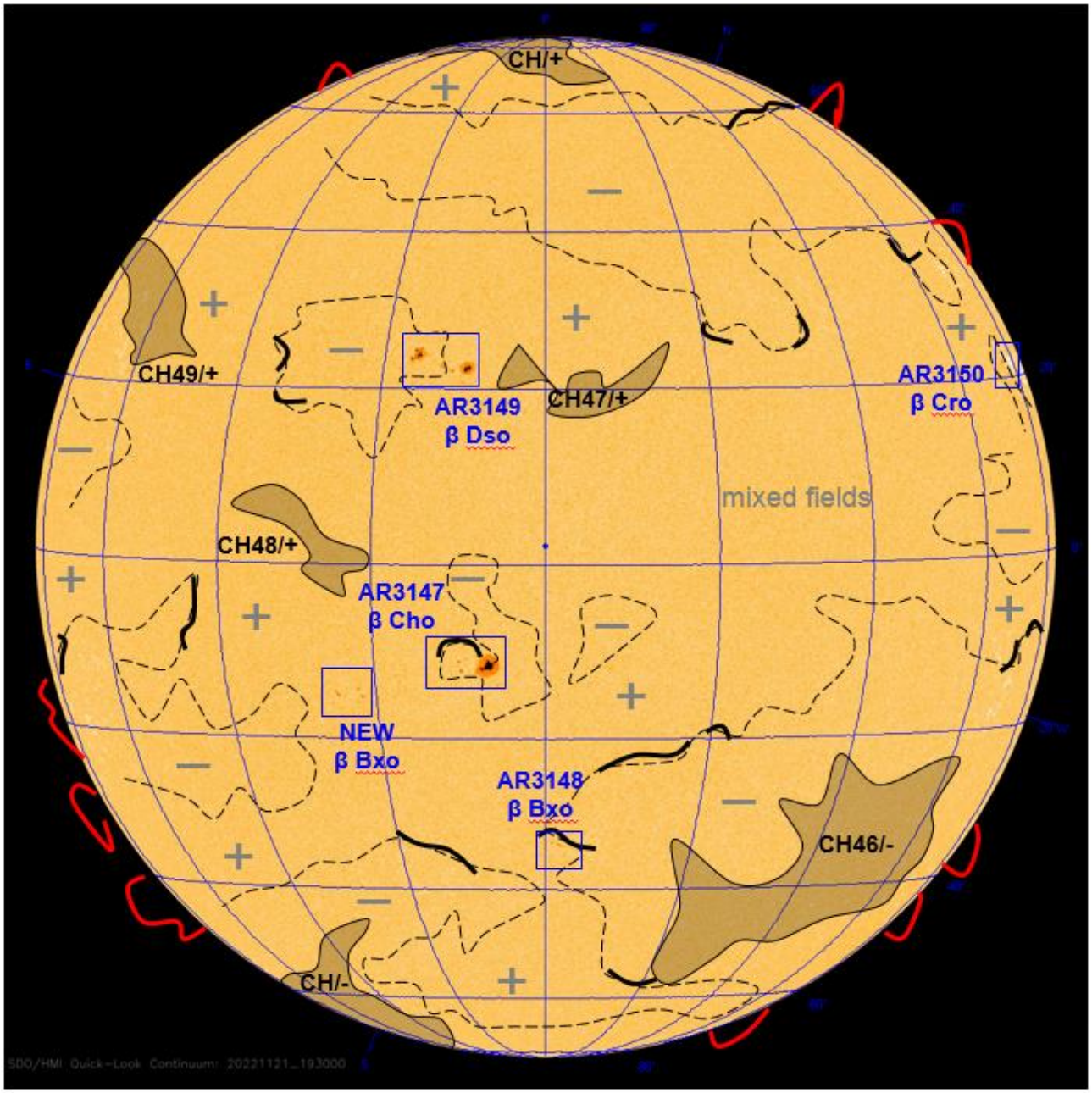
Figure 1. Solar Analysis Valid 21/1930UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

Geomagnetic Storms:

There is currently one CME that features in the four-day forecast. This feature emanated from the northeastern solar hemisphere on Saturday 19 November, but remained anchored for a time at its southern end near 40N20E. This allowed it to 'flick' westwards across the solar meridian as it departed the Sun, and as a result its is inferred to be the emission on coronagraphs heading largely north and west of the Sun-Earth line through the course of that UTC afternoon and evening. This CME is expected to graze Earth later on the UTC day of Tuesday 22 November, however because MOSWOC Enlil has initialised with an overly-high solar wind speed from a

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fuller connection with CH46 than observed, the transit time this is based on will likely be slower. The CME will therefore probably pass 1AU between the UTC days of 22 and 23 November instead, with a Slight Chance of G1 therefore mollified for being later and the risk of G1 now spanning both 24-hour periods.

The coronal hole forecast comprises two and perhaps up to three features: firstly the incumbent CH46/-, which recent STEREO A MAG and PLASTIC data suggest has peaked and ought to wane inside the next 24 hours, with little beyond Unsettled intervals now expected. A slow regime should ensue for a time, before the second coronal hole potentially arrives in the form of CH47/+ on day three, Thursday 24 November. This should again offer a Slight Chance of G1, but ought to be short-lived for its small span on the disc and tenuous character. Confidence then lowers through day four, with CH48/+ due based on 27-day persistence, but changes in its geometry between last pass and recent imagery suggest it may now fall outside the forecast period, perhaps arriving into the coming UTC weekend instead.

The resulting forecast is a glib Slight Chance of G1 on days one to three (Tuesday to Thursday), probably falling on Friday ahead of a further similar magnitude enhancement to come into the UTC weekend. The reliability of the forecast quieter window on Friday 25 November is considered low.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	**G1 to G2**	No	5	5	5	1
Strong	**G3**	No	1	1	1	1
Severe	**G4**	No	1	1	1	1
Extreme	**G5**	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
19/1650	Partial	Filament eruption	NE quadrant	486km/s	Turn of UTC day 22 into 23 November	Low confidence, lack of CH46 fast wind will slow transit. Glancing blow.

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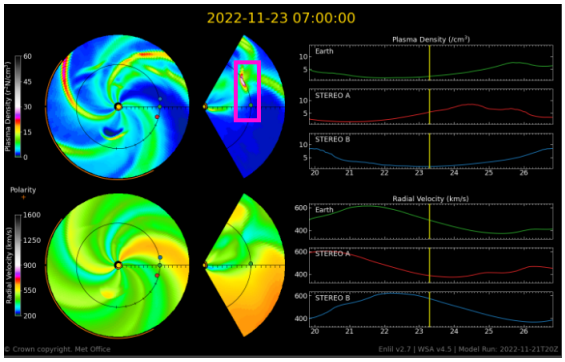
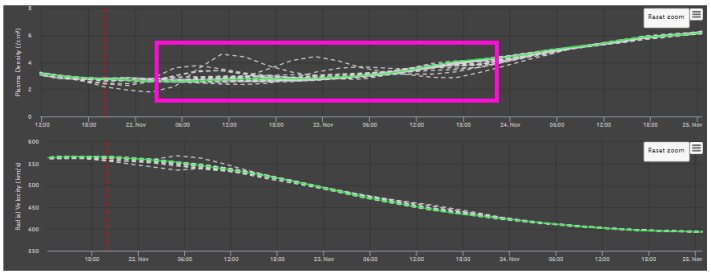
Figure 2: Latest available MOSWOC Enlil run, showing 19 November NE quadrant filament CME as a glancing blow in some ensemble members. Note that the deterministic wind speed is assumed to be near 550km/s into the start of this forecast period, when in actual fact it is much nearer 400 and in decline. This is the rationale for the later than shown possibility of a glancing impact.





Radio Blackouts - X-Ray Flares:

Solar activity has been Low over the past 24 hours, with one of the more active recent spots now departing the Earth-facing side to further reduce the daily Slight Chance of M-class flares. The bulk of the surviving risk is packaged in AR3149 in the northeastern quadrant, with this region responsible for some C-class activity in the past 24 hours. This spot group's growth appears to have stalled in recent hours however, with a spreading and consolidating trend having taken over.

The balance of groups should be largely unchanged after midweek UTC, with one returning region potentially arriving (Ex-3135) as AR3150 leaves, and current observations from STEREO EUVI 195 suggest that this is a relatively unremarkable region. The next arriving region of any size from NSO GONG far-side soundings is perhaps due over the UTC weekend.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No) (%)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 M Class	No	10	10	10	10
Very Active	R3 to R5 X Class	No	1	1	1	1

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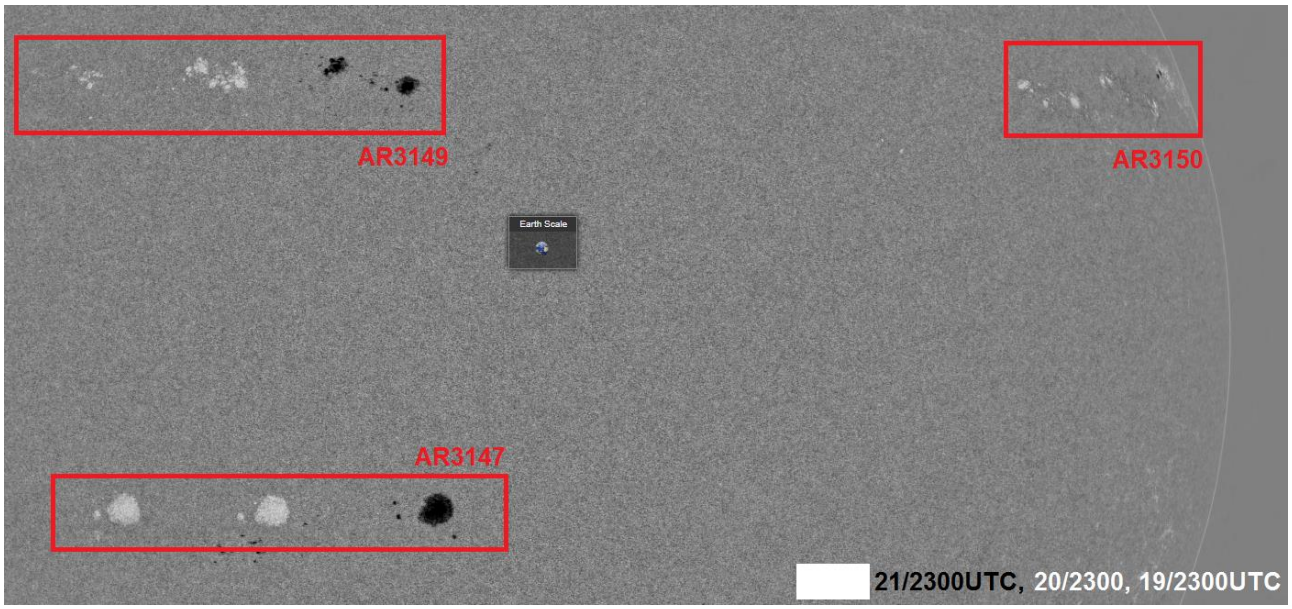
Figure 3: Helioviewer.org-generated HMIIF difference imagery showing evolution in the three largest spot regions in 24-hour intervals over the last 48 hours. Also shown are the Earth and western solar horizon for scale.



Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10MeV) at GEO, as observed by GOES16 is currently at background and expected to persist at this level.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	1	1	1	1
Very Active	**≥ S3 ***	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2MeV) as observed by GOES16 has been near Normal Background levels throughout the last 24 hours. This is now thought very likely to remain the case for much of the coming working week, with the 600km/s forecast potential of CH46/- now no longer expected, with the recent brief rise to 450km/s probably representing the peak of the event. This is unlikely to cause electron counts at GEO to rise significantly beyond those seen at present, and there are no further features of significant magnitude due in the forecast, CH47/+ included.

24-hour integrated electron fluence is Expected to remain below the Active threshold throughout, as on last rotation, with CH48's predecessor the only upcoming feature that proved capable of raising counts, and this is forecast to be both lesser magnitude and later than on last pass, putting any significant electron fluence increase beyond the scope of the coming four days.

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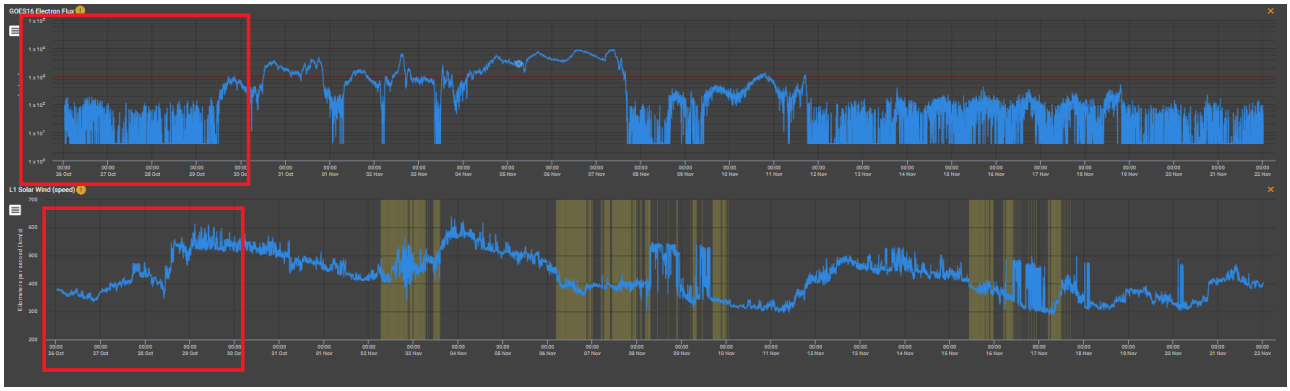
GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	1	5	10
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 4: Analgous upcoming four-day forecast period from the last 27 for GOES16 greater than 2MeV electron flux (top) and driving L1 solar wind (bottom). Note the relative lack of response. The eventual rise in solar wind speed is due to a feature that is expected to be both weaker and later in arriving on this pass, with any upturn in fluence probably into the coming UTC weekend - if at all.



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